

Total Network Data System:

Operating Company Perspective

By J. PFEIFFER, Jr.*

(Manuscript received June 21, 1982)

Implementation and management of the many individual systems comprising the Total Network Data System (TNDS) is a monumental undertaking, with far-reaching impact on a telephone company's organization and methods. This paper describes how one such company—Southern Bell—planned for and converted to TNDS, extending over a number of years. It also discusses the current operations and benefits of TNDS.

I. PRE-TNDS IN SOUTHERN BELL

Before examining TNDS as it exists now within an operating telephone company, it should be helpful to review data-collection procedures before the introduction of TNDS.

1.1 Manual switch counts

Starting with the introduction of dial Step-by-Step (SXS) switching machines in the 1920s, traffic studies were made by manually counting the number of individual switches that were in use, over fixed intervals of time. A large group of clerks would descend upon an SXS central office to make these studies, typically once or twice a year. Counts were made on a sample basis, generally every three minutes, of all

* Southern Bell.

©Copyright 1983, American Telephone & Telegraph Company. Photo reproduction for noncommercial use is permitted without payment of royalty provided that each reproduction is done without alteration and that the Journal reference and copyright notice are included on the first page. The title and abstract, but no other portions, of this paper may be copied or distributed royalty free by computer-based and other information-service systems without further permission. Permission to reproduce or republish any other portion of this paper must be obtained from the Editor.

busy switches in specific groups, such as trunking groups or a switching stage. A supervisor would control the timing of each count with a whistle, and record the number of busy switches for subsequent summarization and calculation. (See Fig. 1.)

The deficiencies inherent in these studies were severe and obvious. They lacked accuracy; there was significant data "skew" due to inherent difficulties in starting and stopping these counts with precision; they were labor intensive; and since they could only be made infrequently, there was a high probability of missing the busy hour or busy season for a given office. Although these traffic studies were the only basis for engineering and administering the telephone network, there was a general lack of confidence in their accuracy. A judgment factor was frequently added to the study results in order to protect service. For this reason, a great many offices tended to be over-engineered in at least some of their switching stages. No one really knows how much capital was wasted in providing unnecessary equipment, but it had to be considerable.

1.2 Introduction of the traffic usage recorder

A major improvement was made in the mid-1950s with the introduction of the Traffic Usage Recorder (TUR). The TUR permitted individual switches to be wired into a "grouped" register, each register



Fig. 1—A manual count being recorded of number of switches engaged with calls. The count was made to determine usage in SXS dial offices.

representing a specific trunking group or switching stage. Also, the TUR made it possible to study traffic in crossbar offices, which had not been practical with the manual count method. (See Fig. 2.)

The TUR had one distinct advantage. It needed to be read only hourly, rather than every three minutes. This sharply reduced the clerical load, and it also improved the data-skew problem. It then became practical to schedule traffic studies more frequently, and confidence in data quality increased. As office sizes grew, however, the traffic-register readings and data-summarization chores grew as well.

1.2.1 Camera added to TUR

A further improvement came in the late 1950s. A camera and flash unit were positioned over groups of up to 160 traffic registers. Under the control of a pre-set TUR timer, the camera took pictures of these banks of registers for as many hourly periods as study needs dictated. The advantage gained was to virtually eliminate data skew, and further reduce the clerical effort in gathering the data and manually summarizing it. Computer programs were created in Southern Bell to process this raw data and produce a family of user-oriented reports downstream.

However, other problems were created. The network administrator who was responsible for doing the traffic study now had to get involved in the manual camera and film-processing procedures. A substantial investment in personnel and equipment became necessary in order to view and keypunch data from the film strips. A key verify procedure was also introduced that virtually eliminated keypunch errors, but at the cost of doubling the key-entry costs. Finally, the work load on the network-administration staff was highly variable since traffic studies were not evenly distributed over time. Since studies are scheduled to capture peak loads, they tend to be concentrated in seasonal and monthly peaks. As a result of the uneven loads, some delays occurred in the manual processing activities.

1.3 OCR experiments

Southern Bell, and one or two other Bell System operating companies, experimented with methods to mechanize this key-entry function during the early 1970s with Optical Character Recognition (OCR) techniques. While our trial was a technical success, it did not prove to be economical and was abandoned after two years.

1.4 Pre-TNDS problem areas

Despite the progress made over the years, our data-collection situation just prior to the introduction of TNDS had four serious problem areas.

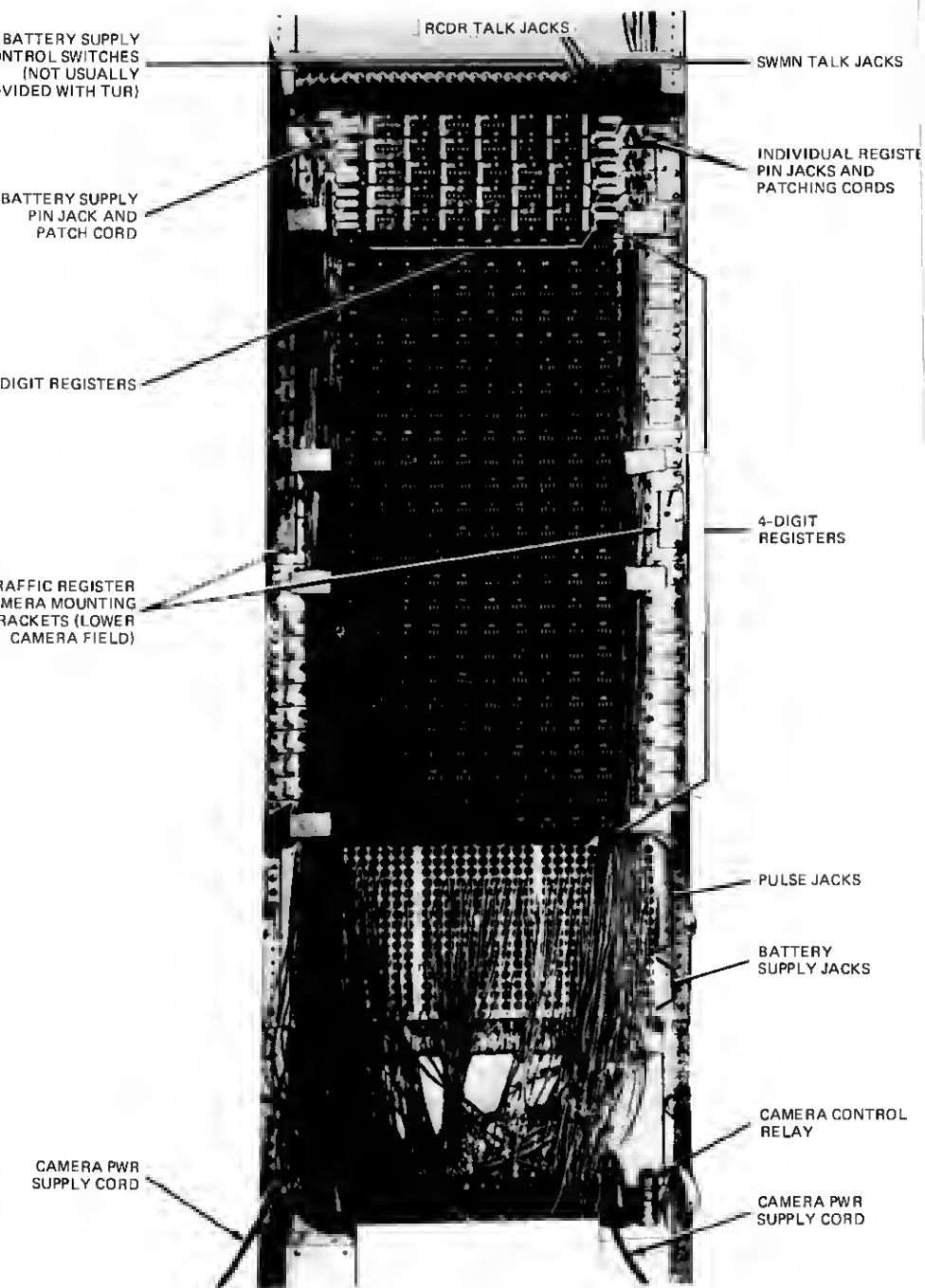


Fig. 2—TUR traffic register cabinet. Camera and hoods are not shown.

First, it was difficult to administer because it required extensive and timely coordination between several departments, each having different priorities.

Second, the data quality was lower than desired. This was due to inherent problems with the cameras, lighting, and film processing.

Third, the completed studies took too long to reach the ultimate user. This was due to the complex sequence of steps necessary, as well as the uneven study schedules. Frequently, the studies had lost much of their value by the time they were received.

Finally, each operating area within Southern Bell had evolved its own set of procedures for data collection. There was a lack of central direction and standardization. The stage was set for TNDs in Southern Bell.

II. TNDs IMPLEMENTATION STRATEGY

2.1 *Criteria for TNDs*

TNDs was approved for implementation in Southern Bell as a corporate-wide project in November 1973. The following criteria were basic to the implementation plan:

1. To realize the maximum benefits, all TNDs modules would be implemented (both available and planned) unless there were compelling reasons for doing otherwise.

2. The "downstream" data processing modules would be implemented on a centralized basis.

3. The "upstream" data-collection (EADAS) modules would be implemented on a decentralized basis. There would be one Engineering and Administrative Data Acquisition System (EADAS) installation in each administrative area, and administrative boundaries would not be crossed.

4. There would be a small, strong centralized staff to provide support to the areas for planning, implementation, ongoing technical assistance, and methods.

5. There would be no downstream processing of key-entry, filmed (non-EADAS) data in Southern Bell, even though TNDs could accommodate it. This would avoid slowing the downstream weekly-coordinated process to the slower pace of key-entry data.

6. The administrative areas would be cut over to TNDs on a phased basis, with each area's schedule determined by need and capital availability.

7. All central offices would interface with TNDs unless they were below a designated minimum size or were to be replaced within about three years.

8. Commercial courier service would be used to transmit EADAS

data-collection tapes to the single centralized processing location, and output reports back to the areas. Figure 3 illustrates the deployment.

2.2 Deployment schedule

The "downstream" software of TNDS was installed shortly before the first EADAS installation to allow for a proper system test. The "upstream" EADAS systems, and their associated administrative staff, were installed according to the schedule shown in Table I.

This sequence was dictated principally by the rapid growth in Southern Florida, which emphasized the need for valid and prompt traffic data. The last three areas were more rural in nature, with slower growth and therefore less critical data needs, at least initially.

Depending upon the number of eligible central offices, one to two years were required to fully implement TNDS within each Southern Bell area. As was expected, the first few offices in each area required a greater amount of time to cut over, until the learning curve was mastered. Each area was given strong support from the centralized TNDS staff, particularly in the planning and early implementation stages.

TNDS was considered fully implemented in Southern Bell by 1980, with the addition of only growth central offices thereafter.

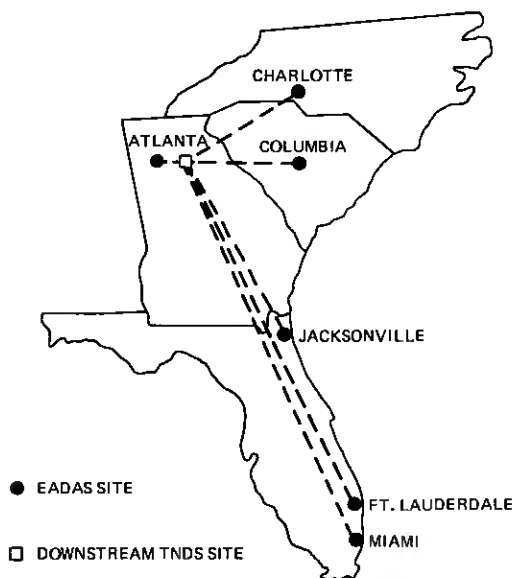


Fig. 3—Routes by which EADAS data-collection tapes and outputs are transmitted between centralized processing location and administrative areas.

Table I—EADAS installation schedule

Area	City	Date
South Florida	Miami	October 1974
Southeast Florida	Ft. Lauderdale	October 1974
Georgia	Atlanta	June 1975
North Carolina	Charlotte	July 1976
North Florida	Jacksonville	June 1977
South Carolina	Columbia	June 1977

III. ORGANIZATION FOR TND S

3.1 *Work centers involved*

Southern Bell follows the guidelines of the Total Network Operations Plan (TNOP) quite closely. TNOP organizes all work functions within the Network Segment into clearly defined centers. The centers involved in our TND S data-collection and report-distribution process are the:

1. Circuit Administration Center (CAC)
2. Network Administration Center (NAC)
3. Network Data Collection Center (NDCC)
4. Minicomputer Maintenance and Operations Center (MMOC)
5. TND S Coordination Center (TCC)
6. Corporate Data Center (CDC).

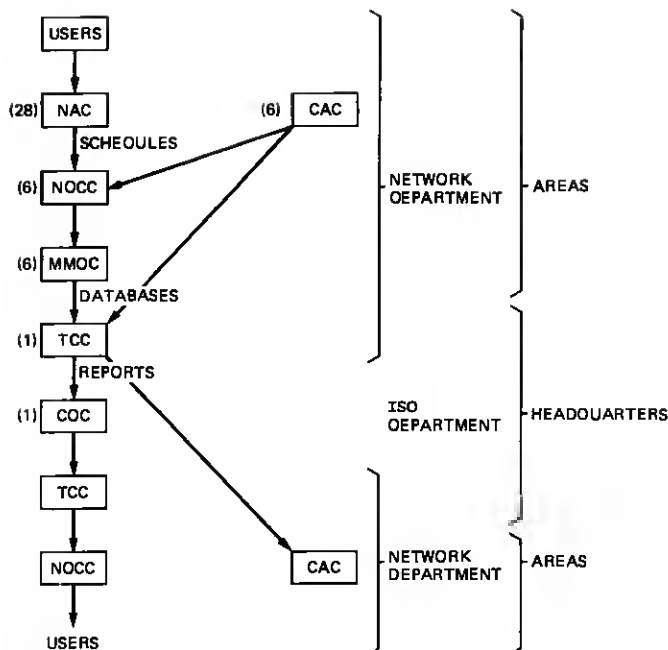
3.2 *TND S data flow*

The technical description of the data flowing through TND S is described in detail in other articles of this issue. Figure 4 illustrates how the data flow is managed by these centers in Southern Bell. It should be recognized, however, that there are significant variations in this process within the Bell Operating Companies (BOCs) due to differences in geography, demography, and corporate structure.

1. There are twenty-eight Network Administration Centers (NACs) in Southern Bell, ranging from three to seven per area. Each NAC serves a geographic subset of an area. All requests for TND S-equipment studies originate in, or are transmitted through, the appropriate NAC to the Network Data Collection Center (NDCC).

2. There are six Circuit Administration Centers (CAC) in Southern Bell, one per area. All requests for TND S-Trunking studies are originated by the appropriate CAC, and are transmitted directly to the NDCC serving that area. The databases for trunking studies (TSS and TFS) are maintained by the CAC.

3. There are also six Network Data Collection Centers (NDCCs) in Southern Bell, one per area. The NDCCs are responsible for monitor-



NOTE: NUMBERS IN PARENTHESES INDICATE THE NUMBER OF CENTERS OF EACH TYPE IN SOUTHERN BELL.

CAC - CIRCUIT ADMINISTRATION CENTER
 COC - CORPORATE DATA CENTER
 MMOC - MINICOMPUTER MAINTENANCE AND OPERATIONS CENTER
 NAC - NETWORK ADMINISTRATION CENTER
 NDCC - NETWORK DATA COLLECTION CENTER
 TCC - TNDS COORDINATION CENTER

Fig. 4—TNDS data flow among administrative centers in Southern Bell.

ing the operation and maintenance of the EADAS Central Control Units (CCUs) in their area, monitoring the operation of the central office data-collection apparatus and associated data links, maintaining accurate record bases, and coordinating as required with the interfacing work centers to resolve problems. In Southern Bell, the NDCC is the principal focal point for data-collection activities in an area, and has no responsibilities other than successful data collection for TNDS.

4. The Minicomputer Maintenance and Operations Centers (MMOCs) are responsible for the operation and maintenance of the clustered minicomputers in their respective areas. EADAS is one of these clustered minicomputers. The MMOC performs preventive maintenance for EADAS on a schedule mutually agreed upon with the NDCC. It also is responsible for transmitting the magnetic tapes generated by EADAS to the TNDS Coordination Center (TCC) on a timely basis, via commercial courier service.

5. The TCC is a single, company-level work center. It serves as an interface between the various network users and the Corporate Data Center (CDC) of the Information Services Organization (ISO), which operates our downstream programs as part of a utility service for all corporate data-processing requirements. The TCC receives magnetic tapes with study data from all area MMOCs, plus all off-line database updates originated by both the NDCCs and CACs. These are formed into data-processing jobs and submitted to ISO by the TCC. The TCC is responsible for tracking the successful completion of the TNDS job through the CDC. A measurement plan has been instituted to determine the timeliness of CDC production for TNDS output.

6. The CDC is responsible for producing the downstream TNDS reports for Southern Bell. Three types of output media are used, depending upon the wishes of the individual users. These are impact print, laser print, and microfiche. Since TNDS processing is organized into stages, the output is spread over the week to level the load on all centers and resources. After each processing stage, the TNDS output is delivered to the TCC promptly.

7. The TCC then reorganizes the TNDS reports into individual user "batches" destined for each area, and transmits the reports back to the six NDCCs and six CACs via commercial courier service. The EADAS tapes are also returned to the MMOCs for reuse on a monthly cycle.

8. The CACs are end users, and upon receipt of their output reports, can immediately put them to use. The NDCCs are the end users for administrative reports that relate to the accuracy and health of the data-collection process; these are used directly by the NDCC. The other user reports are transmitted to the ultimate users in that area by the NDCC.

IV. MANAGEMENT OF TNDS

4.1 Centers involved in TNDS management

Although each center involved in the TNDS data-collection and distribution process is essential for overall success, the "up-front" centers—NAC, NDCC, and CAC—have an especially important role. These three centers are assigned primary responsibilities in the data-flow process through TNDS, including record-base, scheduling, surveillance, and distribution functions. The NAC is assigned the basic central office assignment functions for equipment measurement needs; the CAC maintains trunking databases; and the NDCC provides a centralized center with the technical expertise to interface directly with the TNDS subsystems. The NDCC performs the surveillance of the EADAS CCUs and is an area distribution point for TNDS output.

4.2 Use of TPMP and CSAR

The TNDS Performance Measurement Plan (TPMP) was introduced in Southern Bell in 1979 to improve the management of TNDS. This plan, along with the Centralized System for Analysis and Reporting (CSAR), has added two greatly needed features. As an index plan, TPMP has increased emphasis on the performance and the resolution of problems in the area of traffic-data collection. Additionally, CSAR, as a reporting tool, gives management at all levels specific indications of the success or failure of the TNDS process.

The pre-TPMP environment often found TNDS problems competing for attention with other indexed items. The TNDS problems often were given much lower priorities, and lengthy time intervals could occur before problems would be resolved. Since TNDS results are now being reported along with other indices in Area, Southern Bell, and AT&T results books, TNDS problems are given a higher priority. The weekly reporting and monitoring capability of CSAR also maintains emphasis on any problems until they are resolved.

4.2.1 CSAR reports

The CSAR program itself has proven a valuable reporting tool for TNDS management. By providing reports tailored for any organization or level from an individual traffic unit up to a total company report, CSAR provides management with increased insight into the problems that may need attention. The level of detail available in CSAR makes it useful for first-level managers in the NDCC, NAC, or CAC to monitor and resolve weekly problems in TNDS processing for their specific area of responsibility. It also provides district-level summaries for local management and provides area and company summaries for reporting results. All of these functions are accomplished without user effort other than requesting reports via a dial-up terminal. All CSAR processes are fully mechanized.

4.2.2 Center responsibility

Based on the functional responsibility of the three centers, the nineteen TPMP measurement categories have each been assigned to a specific center for initiating corrective action. Six are the responsibility of the NAC manager, three of the CAC manager, and the remainder belong to the NDCC. Although coordination among these and other centers is frequently required, the specific centers assigned each category are responsible for initiating the necessary action to correct any problems reported by CSAR. In addition, Southern Bell has established an objective level of performance for TPMP results, which is that 90 percent of all traffic units perform in the objective range.

Steady progress has been made in Southern Bell toward this objective since TPMP became an official Bell System measurement plan in July 1980. Both goals of TNDS performance measurement and performance improvement have been achieved.

V. BENEFITS OF TNDS

There are a variety of benefits of TNDS from the operating telephone company perspective, particularly when compared to the pre-TNDS environment.

5.1 Timeliness

TNDS produces reports to the user far more rapidly than the old camera/register arrangements. Surveillance reports are generated by EADAS/NORGEN in near-real time. Further, they are provided directly to the appropriate Network Administration Center, or Circuit Administration Center, only for those offices that these centers manage. In this way, the Company personnel can detect and resolve problems in switching or trunking very early—often before customers are aware of any troubles.

The bulk, downstream reports of TNDS (COER,* load balance, trunk servicing) are also made available in a relatively short time. In general, these are delivered to the user a week after the end of any study period. Prior to TNDS, it typically required four to eight weeks for any meaningful network data to be made available to the user.

5.2 Quality

In the pre-TNDS environment, errors were commonplace. These were caused by keypunching mistakes, camera problems, and database synchronization problems. The quality of TNDS data is far superior, owing to mechanization of database validation procedures and the availability of a standard measurements plant. The shorter turnaround time of TNDS also facilitates prompt detection and resolution of database or hardware problems. Those data errors that do occur are not institutionalized over long periods.

5.3 Quantity

The pre-TNDS environment was labor intensive. This essentially limited the number, scheduling, and quality of studies. The quantity of studies produced by TNDS today would have been impossible just a decade ago. TNDS has also given us studies that are far more sophisticated and detailed than had been possible previously.

* Central Office Equipment Reports.

5.4 Network investment

The family of TNDS reports permits us to engineer and provision the network more efficiently. This improves the existing network utilization and helps us to better forecast growth. Maintenance of the network is also enhanced, allowing further improvement in use of existing facilities. TNDS, therefore, allows fuller use of our present investment and better planning for new capital expenditures.

5.5 Credibility

TNDS lends a high degree of credibility to network data. The improved timeliness, quality, and quantity of data have eliminated the uncertainties of yesterday that resulted in overprovision of facilities in an attempt to protect service.

VI. FUTURE TNDS DEVELOPMENT NEEDS

A formal enhancement procedure is available to the operating telephone companies by which future needs can be submitted, evaluated on a system basis, and, when approved, designed and developed. Enhancements are grouped into annual releases that are accompanied by training and documentation updates.

TNDS is a relatively mature system. Most enhancements now consist of refinements in report content, or in data-processing capabilities.

Southern Bell is a large, geographically dispersed company, and has needs that differ somewhat from those of smaller, more concentrated companies. Our TNDS is logistically dispersed. We see a real need for a system-supported data-transmission capability that would be quick, accurate, yet relatively economical.

There are two "loops" to this need. The first would be a capability of transmitting magnetic-tape data from the deployed EADAS sites to the central CDC for processing. This would avoid the expense of shipping these tapes by courier, would reduce the turnaround time by at least one full day, and would eliminate occasional tape problems caused by the uncertain environment of courier service.

The second "loop" would transmit the TNDS output to each NDCC (or CAC), or alternatively to the individual user. This would also eliminate substantial handling and shipping costs and reduce the turnaround time by at least another full day.

TNDS, although relatively mature, is dynamic. New data needs and improved technology will guarantee that we will always have opportunities for enhancement as long as there is a need for TNDS.

VII. ACKNOWLEDGMENT

The author wishes to acknowledge the contributions of J. S. Rain-

water, Staff Manager, Southern Bell. Mr. Rainwater provided invaluable assistance by reviewing this article and making valuable comments.

AUTHOR

John Pfeiffer, Jr., B.A., 1951, Wesleyan University; M.B.A., 1968, Georgia State University; Southern Bell, 1954—. Mr. Pfeiffer was initially assigned to the Commercial Department, involved in market forecasting and business office operations. Subsequently, he transferred to the Traffic Department and was responsible for Traffic Planning in the Georgia Area. He is currently responsible for Total Network Data System (TNDS) support as well as producing the Total Network Operations Plan (TNOP) and Six-Year Plan in Southern Bell.

